tains, on page 188, a description of twenty-two typical weather maps.

The object of the papers here presented, as stated by the writers, is to invite attention to the assistance a forecast official may derive from a file of weather maps, properly classified and indexed. As was to be expected, each of these writers has his own individual classification and his own method of indexing.

Professor Garriott emphasizes the fact that we must first decide what constitutes weather types. What shall guide us in classifying weather maps? Shall we say that because on two maps the distribution of barometric pressure is similar, these maps therefore belong to the same type? We agree with Professor Garriott that this does not necessarily follow. It is the *behavior* of the highs and lows that must be observed in making our classification, rather than their relative position at any given observation. How have they been built up, and what is their direction and rate of motion as compared with the normal for the month? Other meteorological elements, such as temperature and moisture, must also receive due consideration.

Professor Garriott has also pointed out that heretofore we have not received reports from a sufficiently extensive territory to enable us to classify weather types in the manner he indicates. As a rule, it requires but a few days for highs or lows to develop and pass off to the east of the United States, or even to cross the country from the Pacific to the Atlantic. If they fail to pass off within the usual time, we consider the conditions *abnormal*, and the persistency of highs and lows in maintaining a position just off the New England coast for several successive days has been a fruitful source of unverified forecasts.

Arrangements recently perfected by the Chief of the Weather Bureau whereby reports are cabled to the United States from Europe and the islands of the Atlantic enable us to study the movement of storms across the ocean, and it is believed will lead to more accurate forecasts for the United States; for it is evident that the movement of storms across our own country does not depend alone upon the atmospheric conditions here, but is also largely dependent upon the conditions to the east of us, and these have been particularly hard to determine in winter without direct observations because of the marked difference between continental and oceanic conditions during that season. As Professor Bigelow has pointed out,[2] conditions on the continent of North America in winter are particularly favorable to the development of storms.

There are periods when one storm follows another with almost clockwork regularity, only to be followed by a period of seeming stagnation, when apparently the cycle of eastward movements is blocked. It may well be that a knowledge of the conditions entirely around the Northern Hemisphere will be necessary to accurately foresee these periods of activity and of stagnation.

Forecasting based upon a knowledge of weather types without a knowledge of the forces that operate to produce these types, can not be considered strictly scientific. It is not reasoning from cause to effect, but rather an effort is made to correlate present conditions with conditions that existed at some past time and then it is assumed that like results will follow in each case.

With meteorology in its present state of development perhaps this is the best we can hope to do at present. As has been so aptly stated by the Chief of the Weather Bureau[3] the science of meteorology "now awaits the genius of a Kepler or the magic of a Newton to unravel the mysteries that still baffle the student." It awaits a development of the mathematical laws of storms in such form that they can be applied to the every day problems of meteorology.

[2] Report of the Chief of the Weather Bureau, 1898-99, Vol. II, p. 610.
[3] National Geographic Magazine, 1897, Vol. VIII, p. 65.

If we can learn to identify weather types, we have taken the first step toward a study of the forces that generate the types. The Editor therefore recommends to students of meteorology not only the classification and indexing of weather maps according to weather types, but also a critical study of the more important types, and of the apparently abnormal conditions that occasionally exist.

The forecaster must not, however, rely up a familiarity with types for his success in forecasting. No two storms will be found that are exactly similar in all respects. He must, therefore, learn to distinguish the causes that will result in producing certain types of weather or in modifying the current daily map.—*H. H. K*

THE INFLUENCE OF SMALL LAKES ON LOCAL CLIMATE.

In a letter to the Chief of Bureau the following questions have been asked:

1. Do the lakes in central and western New York have an appreciable influence on the amount of rain, snow, fog, or dew, and is this region consequently favored with a greater certainty of crops than neighboring localitities?
2. Is the climate in their neighborhood modified in any particular so as to make it more desirable?

The following extracts are made from the Chief's reply:

There are a number of ways in which lakes affect the climate of their immediate neighborhood:

1. The reflection of the sun's light and heat from the surface of the water has a decided influence in warming the soil on the east, west, and north sides of the lake. If the banks are steep and high this influence is felt to a corresponding elevation above the water, but if they are very low it is inappreciable.
2. Evaporation from the lake surface throws more water into the air than evaporation from the ordinary fields or forests. There is, therefore, an increased tendency to the formation of fogs during the late night hours and calm weather, and a corresponding protection from frosts, up to the limit of the fog.
3. When the wind blows, the vapor being carried to the leeward side increases the chance of forming fog, cloud, and rain to a distance from the lake, depending upon the strength of the wind and the size of the lake. As the surface of the lake is cooler than the surface of the land in the summer time and in the middle of the day, the wind also tends to diminish the range of temperature on the leeward side of the lake.

The actual numerical amount of these lake influences must diminish with the size of the lake. Thus, on the east shore of Lake Michigan there is a region 5 miles broad, and at the southeast a region 10 miles broad, greatly protected by warmth, fog, and cloud when cold west or northwest winds are blowing. Without having any special local observations to guide our estimates we dare only suggest that the small lakes in central New York probably affect local climates very much as Lake Michigan does, but only to an extent proportional to their areas. That is to say, Lake Cayuga, for instance, having an area of 25 square miles, would have an influence of about one one-thousandth part of that of Lake Michigan, with its area of 25,000 square miles. Although local observers might be well persuaded that an occasional cloud or rain or fog is due to the presence of the lake, yet on the average of many years the influence of the lake would be inappreciable, at least so far as items 2 and 3 are concerned.

With regard to the first item, namely, the reflection of heat from the surface of the small lakes, we think that should be appreciable.

In so far as the small lakes occupy depressions into which the cold air may drain in still, clear nights, they do by that process oppose the formation of frost over the neighboring watershed, but this is an influence independent of the lake water, and depending only on the contour of the depression.

A comparatively thick network of observers with thermometers and rain gages would be necessary to convert these general expressions into figures.—*C. A.*

METEOROLOGICAL OBSERVATIONS WITH KITES AT SEA.[1]

On page 419 of the MONTHLY REVIEW for September, 1901, we printed a short note outlining the work that Mr. A. Law-

[1] A. Lawrence Rotch, in Science, N. S., Vol. XIV, No. 362, p. 896, December 6, 1901.

rence Rotch proposed to undertake with kites on a contemplated trip across the Atlantic. We reprint herewith his account of the results of his experiments, which must be considered as in every way successful. Evidently we need to know more of the upper air conditions over the ocean. As has been shown on page 563 of this REVIEW the conditions on the Atlantic must have an important bearing on the movement of storms across our own country. We therefore heartily indorse any movement that will increase our knowledge of oceanic meteorology.

To the Editor of Science: On page 412 of Science I stated that meteorological observations were about to be attempted with kites flown from a transatlantic steamer. With the aid of my assistant, Mr. Sweetland, and through the courtesy of Captain McAuley, this was accomplished on board the Dominion steamship *Commonwealth*, which left Boston for Liverpool on August 28, 1901. During most of the voyage we were within an area of high barometric pressure that was drifting slowly southeastward and out of which light winds blew. Although these were insufficient to raise the kites, the ship's speed of 16 knots created a corresponding wind from an easterly direction that sufficed to lift the kites on five of the eight days occupied by the voyage to Queenstown. On one of the three unfavorable days, a following wind became too light on the ship for kite flying, and on the two other days a fresh head wind, augmented by the forward motion of the ship, was so strong as to endanger the kites, but had it been possible to alter the course of the vessel a favorable resultant wind might have been produced every day. The maximum height attained was only about 2,000 feet, but with larger kites and longer wire this could have been greatly exceeded. Automatic records were obtained of barometric pressure, air temperature, relative humidity, and wind velocity, which did not differ markedly from records obtained in somewhat analogous weather conditions over the land. The most striking feature was the rapid decrease of the temperature with increasing height in all but one of the flights. The *fall* of temperature was fastest in the first 300 feet, where it exceeded the adiabatic rate of 1° Fahrenheit in 183 feet, but in the last-mentioned flight the temperature *rose* 6° in 450 feet, and during the afternoon remained so much warmer than at sea level. The relative humidity varied inversely with the temperature; the direction of the wind shifted aloft toward the right hand, when facing it, and its velocity generally increased with altitude. These are probably the first meteorological observations at a considerable height in the mid-Atlantic, and have a special importance because they indicate that at sea high-level observations may be obtained with kites in all weather conditions, only excepting severe gales, provided the steamer from which the kites are flown can be so maneuvered as to bring the wind to a suitable velocity.

As the basis of an appeal for the exploration of the atmosphere at sea, the records described were exhibited to the geographical section of the British Association at its Glasgow meeting, and the appointment of a committee with a grant of money to undertake observations with kites in Great Britain, together with the interest manifested there and on the continent of Europe, encourages the hope that my project will be realized. The equipping of the English antarctic vessel *Discovery* with meteorological kites, as mentioned on page 779 of Science, and a similar installation on the German antarctic ship *Gauss*, are unlikely, for various reasons, to have yielded much data on their voyages across the Equator. Although the United States has taken no part in this international undertaking, an opportunity is now offered, without material expense, danger, or hardship to cooperate in a study of the general atmospheric circulation, which is one of the objects of polar exploration. Indeed, for a naval vessel not actually engaged otherwise, the sounding of the atmosphere in the Tropics, whereby the relation of the upper air currents to the winds useful for navigation may be ascertained, would seem to be as legitimate a task as sounding the depths of the oceans and determining the currents and temperatures prevailing there. But if our Navy Department will not authorize this, a private expedition should be organized to investigate the questions mentioned in my letter to Science on a new field for kites in meteorology. Since then Professor Hildebrandsson, of Upsala, who is an eminent authority on the circulation of the atmosphere, writes me that a meteorologist on a steamship provided with kites and also with small balloons to ascertain the drift of the upper winds when there are no clouds, by making atmospheric soundings between the area of high barometric pressure in the North Atlantic and the constant southeast trades south of the Equator, and in this way investigating the temperature and the flow of the so-called antitrades, could solve in three months one of the most important problem in meteorology. If any of your readers will furnish the steamer required, I stand ready to carry out these investigations.—*H. H. K.*

CLIMATE AND CROPS.

The United States Department of Agriculture is continually experimenting to ascertain by what means the farmer may increase the quantity and quality of his crops with the least expense to himself. New varieties of seed are introduced; plant diseases are studied, and remedies suggested; different kinds of fertilizers are analyzed, and likewise the soils from different localities; and the needs of the various soils for the crops to which they are adapted are pointed out.

The Division of Chemistry has for a long time been investigating the effect of climate upon crops, especially also as to its effect upon the quality of the crop. As an example of investigation along these lines, we may refer to the recent publication[1] by Dr. Harvey W. Wiley, Chief of the Bureau of Chemistry, On the Influence of Environment upon the Composition of the Sugar Beet.

In his letter of transmittal to the Secretary of Agriculture, Dr. Wiley refers to this work as

Showing the results of the study of the Division of Chemistry, in collaboration with a number of the experiment stations and with the Weather Bureau, of effect of environment upon the chemical composition of the sugar beet.

The average meteorological conditions at selected stations were considered each month during the season of vegetation, as follows: Mean temperature; total precipitation; hours of sunshine; ratio of actual to possible sunshine, in percentages; number of clear days; number of cloudy days.

In his "Conclusions," Dr. Wiley shows that there is a close relation between latitude and percentage of sugar in the beet; this relation is probably due to the lower temperature in the higher latitudes.

The quality of the beet does not appear to depend upon the amount of direct sunlight it receives, the diffused light coming through the clouds evidently being quite as effective as the direct rays, but the average length of day from sunrise to sunset has a direct relation to the content of sugar in the beet, since the longer the day the higher the percentage of sugar.

The distribution of rainfall by months is also shown to have an important influence upon the sugar content, the best results being obtained with 3 to 4 inches of rainfall per month during May, June, July, and August, and a reduction of the rainfall during September and October.

The close relation between the meteorological conditions and the quality of the sugar beet is clearly set forth in the concluding paragraphs of Dr. Wiley's bulletin, as follows:

The above conclusions, derived from these studies of a year, are quite in harmony with the theories which already prevail in regard to the effect of seasonal influences upon the sugar content of the beet. There are many problems, however, presented by the data, which offer an inviting field of study. Chief among these is the suggestion, which has already been made in a previous part of this bulletin, that the high temperature line which seems to be so disastrous in its effects upon the sugar content of the beet may not produce all these ill effects directly as the result of the high temperature, but indirectly in the effect produced upon the moisture in the soil, the arrest of growth by dry weather, the inducement of a second growth on the accession of rains following a drought, and in other indirect ways. The study of this problem would best be carried on in an irrigated arid region where the temperature is high during the growing months and where the distribution of water on an experimental plat could be absolutely controlled. Other new problems of interest are also presented in studying the effects of direct and indirect sunshine and the distribution of the hours of direct sunshine compared with indirect and with partly cloudy weather.

In the study of these problems so far we are indebted to the cordial cooperation of the Weather Bureau and experiment stations and in the further elaboration of them we rely on the promise of the continuance of this aid. It is certain that environment, of which meteorological conditions form the chief component, have a most marked influence on the chemical composition of crops, and without the assistance of the Weather Bureau it would be difficult to properly study the extent of the changes produced.

This bulletin indicates the relation between the meteoro-

[1] Bulletin No. 64, United States Department of Agriculture, Bureau of Chemistry, Washington, D. C., 1901.